University internationalisation: The effect of domestic tuition fee increases on campus diversity

EC331: Research in Applied Economics

Abstract

This research analyses the effect of increasing UK domestic tuition fees for the 2012/13 academic year on the proportion of international students at universities across England and Wales. Previous efforts have found some effect on applications from higher domestic tuition fees and international students have been shown to be sensitive to a range of influences. Combining these areas of research, university level attendance panel data is used to analyse the changes in university cohorts resulting from the tuition fee rise. It finds that there is a significant increase in international representation relative to domestic students with varying effects by university rank. Higher ranked institutions experienced a more profound increase in the international share of students compared to their lower ranked counterparts, due to a stronger substitution effect between domestic and international demand.

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Contents

1 Introduction

Higher education funding has long been at the centre of the UK political debate. The Browne Review (2010) provided the largest reform to education funding in UK history, as the domestic fee cap rose from a maximum of £3,375 to £9,000 per annum. More recently, the UK government announced another review to assess if students are over paying for undergraduate tuition. Concurrently, the world has continued to globalise, and education is firmly part of this process. Universities around the world have faced growing demand from an increasing number of nations and UK universities have been at the forefront of this race to attract global talent.

Economists have analysed these two forces, albeit separately. Spence (1973) formally introduced the trade off between education costs and future expected earnings as a motivating factor behind education choices. Subsequent empirical literature has supported this argument and evidence from the UK suggests that students place a higher emphasis on financial decisions more than other factors (Wilkins et al. (2013)), and estimated price elasticity of demand for university lies between -0.14 and -0.26 (Sá et al. (2014)). International tuition fees in excess of £20,000 per annum at top UK universities create a similarly difficult decision for international students. Although, factors such as location, campus and university ranking play a more important role in demand from international students (Soo & Elliott (2010)). However, there has been no attempt to acknowledge the interrelated nature of demand for university places by these two student groups, and how domestic tuition fee changes open the door to more international university cohorts and campuses.

Combining these two areas of research in an attempt to assess such interrelated demands, I analyse the UK domestic undergraduate tuition fee rise at the start of the 2012/13 academic year in a fixed effects framework to determine its effect on the internationalisation of UK universities. That is, the change in the share of undergraduate cohorts attributed to international student attendance. This is aided by the assumption of relatively stable international tuition fees over the period, given the absence of any large discontinuous change in fees. This extends further and seeks to determine if there is an accentuated effect for higher ranking universities, which I hypothesise is a result of a stronger substitution effect between UK and international students. This substitution effect is no doubt derived from a higher prestige and reputation from success in league tables driving international interest and demand. Thus, this research should shed some light onto the true effect and longevity of the impact of tuition fees on UK campuses diversity.

The results suggest that there is a significant change in the share of international students after the policy reform in 2012, the strength of which varies by the rank of university. Higher ranked universities have seen the largest change in international student share relative to lower ranked universities. This confirms previous research regarding domestic students, and furthers the hypothesis that, at the expense of domestic students, UK campuses have more international students, implying higher diversity, as a result of increased tuition fees. Although,

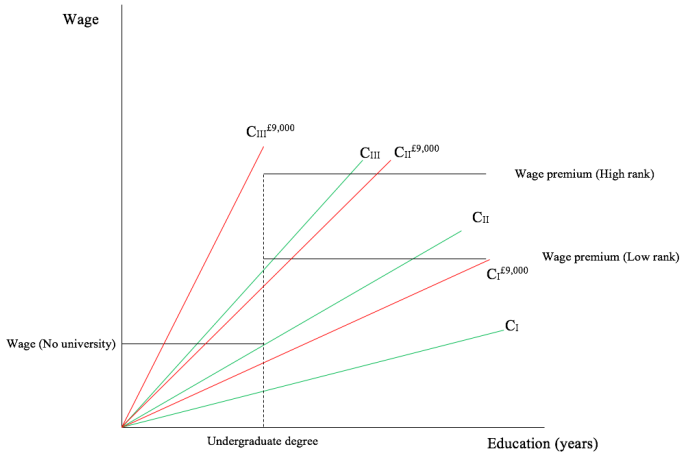
the longevity of this impact remains ambiguous, given the timing of previous and subsequent university legislation.

2 Literature review

2.1 Theoretical framework

Spence (1973), and latterly Weiss (1995), modelled education as a signal for higher productivity in order to obtain a higher wage, making costs pivotal in education decisions.

Figure 1: Expected wage against university costs



The model Spence developed can be adapted to model UK undergraduate decisions in a simple framework. Figure 1 graphically demonstrates the financial decisions of net present value of expected earnings against net present value of costs, which is composed of ability, fees and initial wealth, which aids ability to fund their university expenditure. An example of differing cost curves could be a necessity to take out more loans to finance living costs. Cost curves I, II and III denote three potential different students and denote the wage required to offset the costs they incur from attending university. Pre fee rise, students I and II have a higher expected wage minus costs from attending both types of university, compared to not attending university. Whereas student III only benefits from the earnings boost of a high ranking university. Increasing fees to £9,000 rotates their cost curves to reflect the extra financial burden. Post rise, the graduate wage premium is no longer sufficient to entice student III to attend either type of university, student II requires the wage benefits of a high rank university and student I still strictly prefers to attend university. This simple mechanical example demonstrates how expected domestic demand for both high and low ranking universities falls due to fee changes.

International students are much more price inelastic. Furthermore, international fees didn't experience the same discontinuous change compared to domestic fees. Therefore, it is reasonable to assume that international fees didn't cause any significant changes in demand. Soo & Elliott (2010) note that prestige is a key determinant of international demand; hence, international students demand more places at higher ranking universities, causing excess demand, compared to lower ranking institutions. Thus, the increase in university places available after the fall in domestic demand should cause a larger increase of international students at higher ranking universities. Whilst this is a very crude approximation, it stakes what is a reasonable expectation that more prestigious universities are subject to a stronger substitution effect to international students when domestic demand falls.

This theoretical framework gives rise to the hypothesis that increased domestic fees will increase the international share more at higher ranking universities due to both university groups losing domestic demand, but higher ranking universities can offset this loss with foreign demand.

2.2 Empirical framework

In line with theoretical predications, UK students are sensitive to financial considerations of higher education (Heller (1997); Foskett et al. (2006)). Wilkins et al. (2013) notes that finances are the most important consideration for UK sixth formers outweighing university quality and reputation.

Extending to more robust econometric analysis has facilitated estimates of demand elasticity. Dearden et al. (2011) combined UK labour force survey data creating a pseudo panel data set, to analyse the introduction of fees in 1998 and the subsequent rise to £3,000 in 2006. Across the two policy changes, there was a robust negative relationship between the level of participation and fees, with every £1,000 increase in fees decreasing participation by 3.9%. Dearden et al. (2014) latterly re-estimated the effect of grants on participation, finding that a £1,000 increase in the grants increased participation by 3.95%.

More recently, Sá et al. (2014) assessed the effect of the 2012 fee change on application rates to UK universities, extending the theoretical frameworks to incorporate a net present value for higher education, based on a graduate premium in expected wages. From which two hypothesises were drawn out: firstly, increased tuition fees decreased applications and, secondly, caused students to shift to courses with higher expected earnings. Using UCAS application data, Sá et al. (2014) generated two difference in differences models to evaluate the hypothesis, using the lag between policy implementations across the UK, and Scotland as a control. The nature of using the logarithm of applications data permitted the interpretation of an elasticity of demand for university of between -0.14 and -0.26. This result remains robust when accounting for the reduced numbers of individuals taking a gap year in the year before the policy reform, highlighted by Crawford & Dearden (2010).

It is Sá's empirical analysis that this paper builds upon. However, a key difference is a renewed focus on attendance, rather than applications, which

I argue is a better measure of demand. Students are not obliged to attend university, if they subsequently decide that they no longer value their university offers sufficiently to pay £9,000. Thus, application data can over estimate the post-reform demand and mask the true effect on attendance.

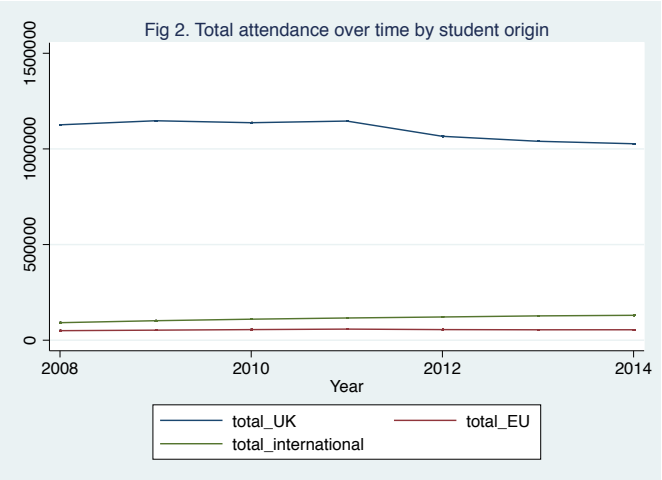
Internationally, Cordaro (1984) noted quantitative literature surrounding decision making is limited in volume. Jena & Reilly (2013) provided one of a handful of approaches in an attempt to further the understanding of international students' motivations to study in the UK. Estimating a fixed effects model using student visa data from 89 developing nations across 2001 to 2008, tuition fees had a significant effect through the exchange rate and national income channels. These both significantly affected visa applications, supporting the work of Agarwal and Winkler (1985). This follows the argument that international students are not so much concerned about tuition fees in GBP, but are more heavily influenced by how it converts to their own local currency. Furthermore, this, to a certain extent, demonstrated the trend to higher level of international education can be attributed to the growth of developing economies facilitating the financial support needed to send students abroad.

Whilst they only use aggregated tuition fee data, Soo & Elliott (2010) provided empirical evidence to partially mitigate this flaw, finding that proximity to London, the university's rank and domestic students' applications to the university provide more significant explanations to variation in participation. Critically these findings influence the use of controls throughout this analysis, and support the argument that a lack of international fee data isn't too detrimental to this study.

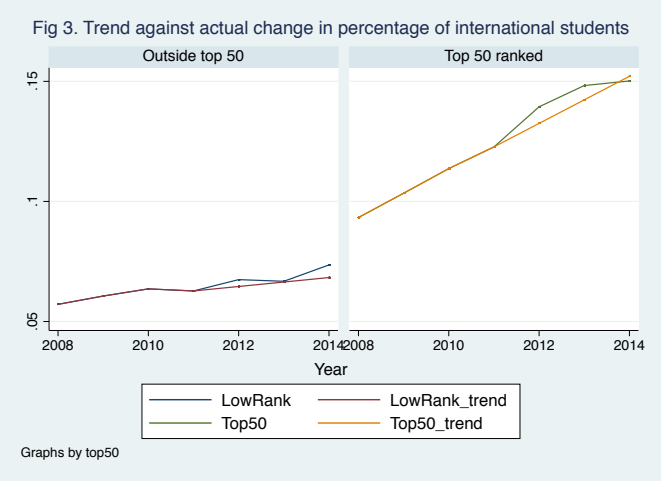
3 Data

This analysis is conducted on 87 universities across England and Wales. Scotland is excluded due to their unique structure of fees whereby Scottish students face free higher education upon studying in Scotland. The data is collected from several sources across the period 2008 to 2014. This period is chosen given two university reforms in 2007 and 2015. In 2007 a tuition fee cap was introduced at £3,000 per annum and in 2015 universities no longer faced a maximum on the number of student admissions per course.

Individual attendance, location and campus data is collected from the UK Higher Education Statistics Agency. Total undergraduate university attendance changed notably over the period, peaking at 1.32 million students in 2011, before failing to its lowest level in 2014 at 1.21 million. As detailed by figure 2, the fall in attendance after the tuition fee rise is as a result of lower UK and EU student attendance, with UK students falling by 79,655 between 2011 and 2012. Whereas international student numbers increase year on year from 91,490 in 2008 to 130,130 by 2014. EU students are not included in international students as European laws require that they face the same fees as UK students. Naturally, this leads to an increasing proportion of international students.



Summary statistics for the control variables are given in table 1, including both international and domestic student specific controls. More pertinently, the correlation between proportion international and rank is -0.5632, which denotes higher ranked universities have more international student cohorts. Building upon the hypothesis posed, the correlation between proportion international and year is 0.2866 and 0.1383 for the top 50 and lower ranked universities respectively, which suggests differing international demand across the groups. Figure 3 demonstrates such a split, with the trend growth, defined as trend between 2008 and 2011 extrapolated out to 2014, and actual changes over time. The comparison demonstrates a potentially larger policy reaction above trend at high ranked universities, with other universities experiencing more random changes. This further motivates the hypothesis that higher ranking universities experienced a more alarming change.



4 Methodology

The empirical approach to determine the effect of the tuition fee rise, is built up in increasing complexity, in order to account for as many control variables, and other biases as possible. Initially, a pooled OLS is estimated, accounting for key university level controls:

$$Propinternational_{it} = \alpha_0 + \beta_1 trend_t + \beta_2 postreform_t + \beta_j X_{it} \qquad (1)$$

The dependent variable is the percentage of international students in a university undergraduate cohort. The post-reform dummy variable coefficient, β_2, is the variable of interest records 1 for 2012 onwards and 0 for before the fee rise, and is used to determine the effect of the tuition fee rise. The vector $\beta_j X_{it}$ denotes the control variables, including drivers of international demand following the empirical analysis of Jena & Reilly (2013) and domestic students demand.

In order to increase the validity, and demonstrate the innate issues of pooled OLS, the empirical approach of Sá et al. (2014) is built upon, giving rise to the following fixed effects model:

$$Propinternational_{it} = \alpha_i + \beta_1 trend_t + \beta_2 postreform_t + \beta_j X_{it} \qquad (2)$$

This differs, given data limitations, from Sá et al. (2014) by not making use of a difference in differences model. This is primarily due to the aforementioned differences in fee structure of Scottish universities, which would otherwise have constituted a suitable control group. This is estimated using the entire set of universities, and is tested to determine differing effects across ranks.

Figure 3 graphically demonstrates such a difference between high and low ranking universities. High ranking universities are defined as universities in the top 50 throughout the defined time period. Given the distinct paths of growth, the model is tested, using both rank and a dummy variable highrank, which registers 1 for top 50 universities and 0 otherwise, to verify that structural differences exist between the groups.

Subsequently, high and low ranking universities are estimated separately, with different specifications. High ranking universities have a distinct and regular trend increasing year on year before and after the policy change for international share. The inclusion of a trend and yearly effects causes issues of collinearity, hence, the inclusion of a trend causes the omission of yearly fixed effects. However, the smooth trend supports the view that this omission will not significantly bias the results. In contrast, lower ranked universities demonstrate no clear trend. To account for the variation, year fixed effects are estimated in place of trend and treatment effect, which makes the interpretation somewhat more intricate.

High rank:

$$Propinternational_{it} = \alpha_i + \beta_1 trend_t + \beta_2 postreform_t + \beta_j X_{it} \qquad (3)$$

Low rank:

$$Propinternational_{it} = \alpha_i + \sum_{j=2009}^{2014} \gamma_j year_j + \sum_{j=2009}^{2014} \lambda_j year_j rank_{it} + \beta_j X_{it} \tag{4}$$

Included in the high rank specification is location varying time trends. Using London as the base, it allows different regions to experience different growth rates. Soo & Elliott (2010) noted that proximity to London is an important factor and as such, one would expect different regions to attract students at a different rate. The inclusion allows for further regional heterogeneity to be captured within the model.

Further to the above specifications, one should note that the high ranking specification is tested to determine if the reform changed the trend growth in international attendance, which aids the determination of whether the policy resulted in a short run, or longer term effect. Theoretically, if the trend change is decreased post-reform, it suggests a convergence back towards the pre-reform trend and, thus, the policy caused only a short run effect. In addition to this trend analysis, further robustness checks are utilised to assess the potential for short run and placebo effects more rigorously.

As the low ranking universities include yearly fixed effects, careful analysis will elicit the post-reform effect by testing coefficient differences between the pre and post-reform years. Contrary to the high rank model, the specification allows short or longer run effects to be determined directly from the yearly dummies.

5 Results

5.1 Initial results

Initial analysis using the pooled OLS model is in table 2. Column one outlines the basic model before the inclusion of controls in columns two and three, further testing the specification for changes in trend growth.

The post-reform dummy, which is intended to capture the effect of the tuition fee change, remains insignificant throughout the different specifications of the model. This is a direct result of pooled OLS, which fails to capture the heterogeneity between universities. Time invariant variables, such as London which increases international attendance by 7.1 percentage points, exemplify the importance of omitted heterogeneity controls. Furthermore, the effect of rank on the international share at a university is significant, a one rank increase decreases international share by 0.11 percentage points. This extends to ability attract students over time, shown by the rank trend multiplicative in column 3; a university ranked 5th expects the international share of the student population to increase by 1.15 percentage points per year, whilst a university ranked 50th expects a 0.7 percentage point increase in international share. Thus, two inferences can be drawn from these results: pooling universities with large het-

erogeneity biases the results, and there is evidence of varying ability to attract international students by rank.

Table 3 details an advancement onto a fixed effects model to capture university heterogeneity. There is a significant policy effect, with international share of student populations rising by 0.87 percentage points after the reform. Trend growth remains significant and the addition of regional trends, where London is the base, captures further heterogeneity and inter-region ability to attract increasing international demand.

Column three is the first major step to aligning the results with the hypothesis. Allowing the trend and post-reform dummy to vary by rank reveals a major insight into the differences across universities. Most significantly, the post-reform coefficient increases to a 1.34 percentage point increase, and the multiplicative implies a one place reduction in rank causes this to diminish by 0.01 percentage points. Testing this effect at different ranks causes the policy effect to become insignificant below 63rd in national rankings. The implication is that lower ranked universities felt less of a substitution effect following the policy, which can be reconciled with the hypothesis and motivates the following analysis to test the need for different models by high and low rank.

Pooling all universities into one group poses the assumption that there is no structural difference in the post-reform and trend effects between high and low ranked institutions. That is, it assumes a linear relationship between rank and the reform effects and trend, which is unlikely to be a realistic assumption. Tests by rank and the dummy variable highrank find a highly significant difference between coefficients (A.3). This confirms the belief that two different models need to be estimated to facilitate structural differences between high and lower ranked universities.

5.2 High ranking universities

Table 4 contains the results of the High ranking universities model, where column two outlines the final model for the subgroup. The major difference that can be taken from the separation of the model is the more homogenous effect of the policy change across the high ranking universities. The rise in fees increases the international share of student populations by 0.83 percentage points, which represents a 5.5% increase on the mean international share of high ranking universities in 2012. Furthermore, and importantly in the context of policy, the lack of a significant coefficient on a trend and post-reform multiplicative demonstrates that there is no significant change in the trend rate of growth. This implication is important; it denotes that the effect of tuition fees has increased the level of international students in high ranking universities permanently above the initial trend. Thus, the process of internationalisation of higher education institutions has been increased indefinitely as a result of £9,000 tuition fees.

A test for a homogenous effect across the top 50 universities demonstrates that there is no variation in effect by ranks, indicating universities experienced an equal percentage point change in international share. Rank does continue to have an effect on the trend change, however, the sign is reversed, suggesting

that the highest ranking universities, whom already have a large international student population, have less change to undergo.

Table 4: High rank results (University fixed effects)

VARIABLES	Basic Model	Final Model
trend	0.0083***	-0.0004
	(0.0030)	(0.0042)
post-reform	0.0078**	0.0083***
	(0.0030)	(0.0026)
rank	-0.0009	-0.0008
	(0.0005)	(0.0005)
rank * trend		0.0002**
		(0.0001)
Controls	Yes	Yes
Location specific trends	No	Yes
Constant	0.119	0.150
	(0.185)	(0.146)
Observations	259	259
R-squared	0.589	0.723
Number of uniqueID	37	37

Robust standard errors in parentheses, clustered by university
*** p<0.01, ** p<0.05, * p<0.1

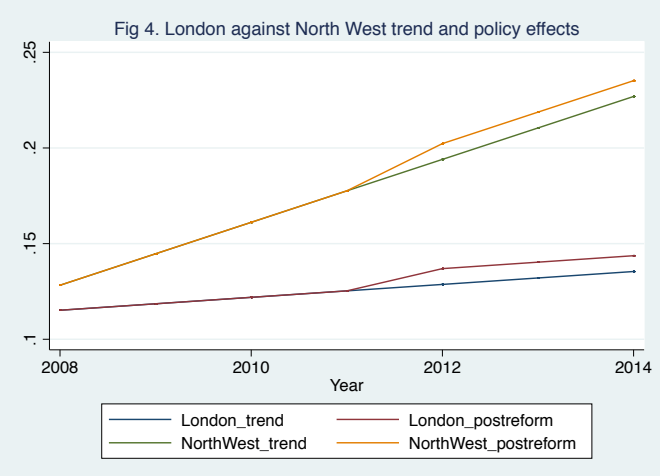


Figure 4 graphically demonstrates these results at mean values, using the London base case trend against North West universities, which experienced the

fastest rate of change. Comparing against the expected trend, the difference demonstrates the 0.83 percentage point increase in international share as a result of the fee change and supports the hypothesis initially posed; high ranking universities experienced a large substitution to international demand.

5.3 Low ranking universities

Table 5 contains the results of a revised model for low ranked universities. Yearly effects are included given substantial yearly variation and multiplicative terms permit yearly dummies to differ by rank. This allows the post-reform effects to be larger for universities close to the top 50, and to determine when the policy effect tends to zero.

Column three shows the effects, at mean values of rank, of the yearly dummies. Initially, there is evidence to suggest that the proportion of international students is increasing year on year, with 2.6 percentage points higher share of international students in 2014 compared to 2008. It further implies a 0.7 percentage point increase in share immediately after the fee rise, which increases further in 2013 and 2014. These coefficients are tested to elicit the true differences between the pre and post-reform years, including by different ranks, in order to determine the policy effect.

The outcomes have two very important results (A.4). Primarily, at mean, 1st and 3rd quartile ranks there is no significant increase between pre-reform years compared to 2008. Thus, there is no rise in the share of cohorts attributed to overseas students before 2012. However, it is not true of the post-reform years, whilst the 3rd quartile post-reform years are insignificantly different compared to 2008, the post-reform years are significantly larger than all pre-reform years for the mean and 1st quartile of universities. Secondly, 2012 has a significantly smaller effect compared to 2013 and 2014 for the mean and 1st quartile of university ranks.

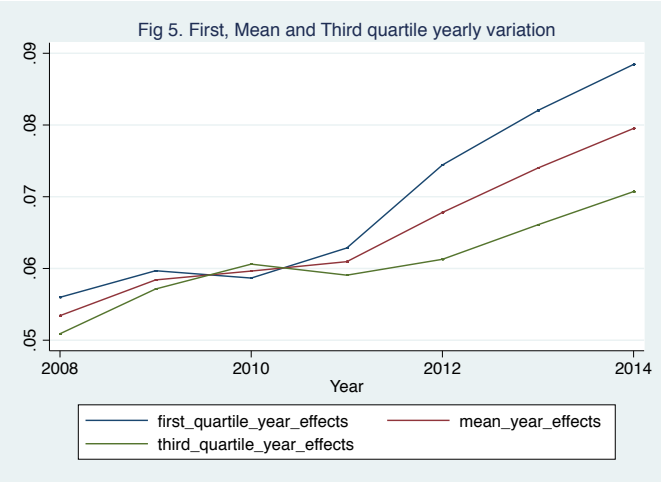
From this it can be inferred: There is no trend of increasing international student share before the policy and only the higher ranked universities have variation between yearly effects post-reform, implying these universities increasingly turned to international admissions post-reform with a weak substitution effect. In addition, only the higher ranking universities within the group experienced a significant post-reform effect. This evidence is demonstrated in figure 5, which shows the model predictions at mean, 1st and 3rd quartile of ranks. The third quartile has very little variation over the period, resulting from no substitution effect. In contrast, there remains a weak substitution effect for universities at the higher end of the spectrum, with a sharper increase in international share for the 1st quartile of rank.

Consequently, there is evidence to support the hypothesis that there was an increase in the proportion of international students, however, the effect diminishes the lower a university is in league tables. The policy effect reaches zero, and is statistically insignificant for ranks above 90.

Table 5: Low rank results (University and year fixed effects)

VARIABLES	Basic Model	Final Model	Yearly effects
2009	0.0050**	-0.0012	0.0050
	(0.0021)	(0.0060)	
2010	0.0045	-0.0109	0.0062
	(0.0049)	(0.0132)	
2011	0.0066	0.0044	0.0075
	(0.0060)	(0.0135)	
2012	0.0140**	0.0341**	0.0144
	(0.0068)	(0.0162)	
2013	0.0203**	0.0471**	0.0206
	(0.0089)	(0.0193)	
2014	0.0252*	0.0570**	0.0261
	(0.0128)	(0.0222)	
rank	-0.0003	-0.0002	
	(0.0002)	(0.0002)	
2009 * rank		0.0001	
		(0.0001)	
2010 * rank		0.0002*	
		(0.0001)	
2011 * rank		0.00003	
		(0.0001)	
2012 * rank		-0.0002	
		(0.0002)	
2013 * rank		-0.0003	
		(0.0002)	
2014 * rank		-0.0004*	
		(0.0002)	
Constant	0.103	0.0887	
	(0.0926)	(0.0717)	
Observations	364	364	
R-squared	0.271	0.333	
Number of uniqueid	52	52	

Robust standard errors in parentheses, clustered by university
*** p<0.01, ** p<0.05, * p<0.1



5.4 Robustness

The results indicate a significant effect, diminishing over rank at the lower end. Whilst the low ranking model allows a full examination of the results with regards to potential short run or placebo effects from focusing on yearly fixed effects, the model for high ranking universities is open to be misinterpreted as a sustained rise in the level of international share above trend, instead of potentially a short run or placebo effect.

Table 6 shows that the model is robust to changes in the base year; dummy variables detailing a pre-emption or late reaction to tuition fee changes are not significant. This can be attributed to the structure of the reform; students who were already at university before the reform continued to pay fees at the pre-reform level. Students entering university in 2010 or 2011 would not be affected, hence, it is sensible to assume that university choices were not affected by the government decision to raise fees for the academic year 2012/13.

Analysis of a one-year shock is insignificant, validating the argument that the increased fees had a longer term effect. This extends to only a short run shock, defined as lasting only two years. The inclusion of a dummy variable finds no significance over and above the post-reform coefficient. Thus, the model is robust over the time period specified.

5.5 Limitations

Omitted variables, the shortened time frame of the model and the lack of a control group for the analysis provide avenues for improvement. However, there is sufficient grounding to argue that improvements to the model are unlikely to achieve dissimilar results, especially as the removal of several flaws would be expected to strengthen the results.

The lack of a control group is difficult to address; a control group of Scotland or Ireland would create the ideal experiment to use difference in differences.

Although, Scottish students face a different decision, they have the option to study in Scotland for free, or face the same charges as other students by studying in other parts of the UK. This causes a self selection bias, and one could expect students to stay in Scotland causing a lack of independence between the two countries and creating an endogeneity problem.

The restriction to seven years causes interpretation issues. Robustness to a short run response dummy doesn't equate to a concrete conclusion that the results can be interpreted as an indefinite effect. The concern persists as the coefficient on the short run dummy is considerably larger than that of the post-reform dummy, suggesting a short run effect is more likely. Additionally, the data in figure 3 suggests a return to trend by 2014; hence, it would have been preferable to test over a longer time frame. If the cap on maximum course attendance wasn't removed in 2015, a more robust test of a short run effect could have been undertaken. Thus, it is certain that the policy had an effect, but its duration remains ambiguous.

It is possible to mitigate, at least partly, the biases of omitted variables. Soo & Elliott (2010) argue that international student fees aren't the most important decision in variation of international students; London and campus environment play a more integral role, which are both controlled for. Furthermore, following Jena & Reilly (2013), US GDP acts as a proxy for global economic health, which partially controls for increasing wealth driving international student demand. In addition, it is important to understand the main aim of this analysis is to look at how a discontinuous jump in domestic fees affected the student body. International students experienced fee changes in line with inflation, and as such the shock to domestic fees will have far more of an important impact than international fees.

Also, the additions of the national scholarship fund of £50 million per annum and government expenditure on education are omitted due to collinearity. However, their inclusion would only have strengthened the effect of the reform, as a scholarship fund should have a positive effect on domestic attendance. In addition, competitors' admissions policies over the period, such as Canada and USA, were stable with no fee changes that would indirectly increase international attendance in the UK.

Finally, the low ranking interpretations should be taken with caution as this analysis implies all yearly variation is driven by the change in tuition fees, which is a very unrealistic, but unavoidable assumption without further controls.

6 Conclusion

The aim of this research is to analyse the UK domestic undergraduate tuition fee rise at the start of the 2012/13 academic year and determine its effect on the internationalisation of UK universities. Overall, there is significant evidence of increased international share of undergraduate cohorts as a result of tuition fee increases; the effect diminishing the lower the university lies in rankings due to a weakening substitution effect. High ranking universities experienced an increase

of 0.8 percentage points in share of international students, in comparison to a 0.7 percentage point increase in lower ranked universities at mean characteristics. Although, this should be taken with caution; the endurance of the effect remains ambiguous and other effects may have influenced the low ranking interpretation.

The significant internationalising effect on the student body from raising tuition fees opens up interesting avenues for further research. Potential benefits of a more rounded education from more international cohorts with a wider range of global views and the effect of an integrated campus on student performance would be an eloquent extension to explore the implications for attainment. Such research would be timely given the impending review into tuition fees. The diversity of universities should not be overlooked when considering the financial opportunities available to UK students, especially as this research suggests every £1,000 reduction in fees could induce a 0.15 percentage points fall in international share with potential unintended effects on attainment.

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A Appendix

A.1 Summary statistics

Table 1a: Summary statistics of dependent and control variables

Variable	Observations	Mean	S.D.
Proportion international	623	0.0947114	0.0659788
Rank	623	56.16533	33.83671
Entry standards	623	326.3002	86.03122
Student satisfaction	623	5.418613	3.834987
Graduate prospects	623	65.38587	9.578258
Student-staff ratios	623	17.71014	3.490209
Good honours	623	62.48138	11.18811
Degree competition	623	85.33965	7.663031
Academic service spend	623	965.4238	413.006
Facilities spend	623	341.5056	142.0566
Research quality	623	2.723226	1.165036
London university	623	0.2134831	0.4100952
Campus	623	0.46875	0.501642
English university	623	0.9550562	0.2073473
United States GDP	623	50209.14	1000.644
Government expenditure	623	12907.29	1575.827
Median graduate salary	623	19928.57	678.1754
National Scholarship fund	623	28,600,000	36,500,000

Variables regarding rankings data is collected from the Good University Guide. Each university has seven observations of each variable over time. Variables including median graduate salary, national scholarship fund and government expenditure don't vary by institution. US GDP is taken from the IMF statisitics database.

Table 1b: Correlations between time and proportion of international students

Variable	Year	Rank	Post-reform
Year	1.0000		
Rank	0.0052	1.0000	
Post-reform	0.8660	0.0042	1.0000
Proportion international	0.1766	-0.5632	0.1571
Proportion international (top 50)	0.2866	-0.2452	0.2539
Proportion international (Outside top 50)	0.1383	-0.2538	0.1241

Table 1c: Variable description

Variable	Description
Post-reform	*0 for 2008 to 2011, 1 for 2012 onwards after tuition fees rise from £3,000 to £9,000*
Proportion international	*Percentage of international students at the university.*
Highrank	*Dummy variable registering 1 if a university was in the top 50 of the rankings consistently across the period.*
Rank	*Rank in the Good University Guide annual rankings.*
Entry standards	*The average UCAS tariff points score of students entering the university.*
Student satisfaction	*Average score from students out of 5 of satisfaction.*
Graduate prospects	*Employability of graduates receiving a first class degree. Max score 100.*
Student-staff ratios	*Number of students per staff member.*
Good honours	*The percentage of students receiving a first or upper second classification on their degree*
Degree competition	*Percentage of students completing their degree*
Academic service spend	*Expenditure per student on all academic services*
Facilities spend	*Expenditure per student on staff-student facilities*
Research quality	*Average quality of research as measured by the Research Excellence Framework. Max 4.00.*
London	*Dummy variable for whether the university is in London*
Campus	*Dummy variable for campus or city university*
English	*Dummy variable distinguishing between UK and Welsh universities*
United States GDP	*US GDP proxying for international macroeconomic conditions. Taken from the IMF international data.*
Government expenditure	*UK government expenditure on higher education. Taken from UK government statistics database*
Median graduate salary	*Median bachelor degree salary 6 months after leaving university*
National Scholarship fund	*Introduced in 2012/13 academic year. Provided money to domestic students from less affluent backgrounds to increase university participation post tuition fee rise.*

A.2 Pooled OLS

Table 2: Pooled OLS Results

VARIABLES	Basic Model	Model 2	Model 3
trend	0.0054***	0.0051**	0.012***
	(0.0007)	(0.0024)	(0.0040)
post-reform	0.0022	0.0011	0.0097
	(0.0018)	(0.0039)	(0.0134)
post-reform * trend			-0.0026
			(0.0032)
rank		-0.0011***	-0.0007
		(0.0004)	(0.0004)
rank * trend			-0.0001**
			(0.0000)
Controls		Yes	Yes
Constant	0.0724***	0.299***	0.210
	(0.00635)	(0.113)	(0.127)
Observations	623	623	623
R-squared	0.031	0.578	0.582

Robust standard errors in parentheses, clustered by university
*** p<0.01, ** p<0.05, * p<0.1

Pooled OLS results demonstrate the innate issues of heterogeneity omission. Including a rank and trend multiplicative in column 3 begins to highlight such issues, with higher ranked universities having a much sharper increase year on year compared to lower ranking universities. This motivates a movement to more complex models where heterogeneity and further controls can be captured by the university fixed effects model.

A.3 Fixed effects and subgroup determination

Table 3a: University fixed effects regression analysis

VARIABLES	(1)	(2)	(3)
trend	0.0024	0.0025	0.0072***
	(0.0016)	(0.0021)	(0.0022)
post-reform	0.0087***	0.0087***	0.0134***
	(0.0022)	(0.0024)	(0.0030)
rank	-0.0003	-0.0003	-0.0001
	(0.0002)	(0.0002)	(0.00021)
rank * trend			-0.00004**
			(0.0000)
rank * post-reform			-0.0001**
			(0.0001)
location * trend		Yes	Yes
Controls	Yes	Yes	Yes
Constant	0.0589	0.0482	0.0531
	(0.0793)	(0.0752)	(0.0675)
Observations	623	623	623
R-squared	0.415	0.448	0.481
Number of universities	89	89	89

Robust standard errors in parentheses, clustered by university
*** p<0.01, ** p<0.05, * p<0.1

Table 3a represents an advancement to university fixed effects analysis, where individual university heterogeneity over time is captured. Variables such as distance to London, which heavily influences international demand, is accounted for in the individual university dummies. There is a clear change from the pooled OLS analysis, as the post-reform dummy is significant and positive. This denotes an increase in the international share of the student population and is decreasing in rank. Trend remains significant throughout the analysis despite the London trend being insignificantly different from 0. The final column moves towards the final models and gives evidence for why the split hypothesis may require different models due to varying structures of universities by rank. Lower ranked universities rely less on international attendance due to a lower prestige drawing in students, this is represented with a much lower post-reform and trend effects as the rank decreases, which is a proxy for prestige.

As mentioned in the results section, the effect falls to insignificant and zero for the lowest ranked universities in the model outlined in column three. Testing at the third quartile of ranks (rank = 86th), a test on the overall effect of the post-reform effect is insignificant with a p-value of 0.6289. Further testing finds that there is no significant effect of the policy for universities ranked 63 or below. This falls within the hypothesis provided that higher ranked universities have a larger substitution effect and, therefore, a significant change in their cohort composition.

Table 3b: Subgroup determination and testing

VARIABLES	Sub-group Model
trend	0.0088**
	(0.0036)
post-reform	0.0352*
	(0.0178)
rank	0.0039**
	(0.0017)
rank * trend	-0.0001
	(0.0000)
rank * post-reform	-0.0007***
	(0.0002)
trend * post-reform	-0.0052
	(0.0046)
rank * trend * post-reform	0.0001**
	(0.0001)
Constant	-0.133
	(0.132)
Observations	623
R-squared	0.547
Number of universities	89

Robust standard errors in parentheses, clustered by university
*** p<0.01, ** p<0.05, * p<0.1

Table 3b is pivotal in determining the sub groups which will be used to build the final models. It is clear that rank is significant and variables individual effects are heavily influenced by where a university sits in the rankings. This is true of both the post-reform and trend effects. In determining the sub groups each variable in the model, including the controls, are allowed to vary by rank and, although not included in table 3b, Highrank. This variable registers 0 for universities outside the top 50 and 1 otherwise. Testing for systematic differences in coefficients by rank and by Highrank gives p-values of 0.0000. This concludes that there is a systematic structural difference and, hence, a need for separate models. Obviously this cannot be done by rank, and dividing between top 50 and other universities becomes the natural point to split at. This is due to the significant test and allows sufficient observations for a model to be satisfactorily estimated.

A.4 Low rank model testing

Table of tests to determine the policy effect for low ranking universities

Test	P-value
Test yearly dummy significance at rank=64 (1st Quartile)	
2009	.1181
2010	.6644
2011	.3136
2012	.0174
2013	.0078
2014	.0153
Test yearly dummy significance at rank=80 (mean)	
2009	.0122
2010	.2000
2011	.1968
2012	.0256
2013	.0146
2014	.0283
Test yearly dummy significance at rank=97 (3rd Quartile)	
2009	.0045
2010	.0206
2011	.1428
2012	.0928
2013	.0661
2014	.0776
Test difference between 2011 and 2012 at rank=64 Significant increase between immediate pre and post-reforms years	.0000
Test difference between 2011 and 2012 at rank=80 Significant increase between immediate pre and post-reforms years	.0009
Test difference between 2011 and 2012 at rank=97 No significant increase between immediate pre and post-reforms years	.4157

The tests here look to determine if there are difference in the yearly dummies at a range of different ranks. It doesn't give the full picture of outcomes, however, it shows how past a certain rank the effect falls to zero and insignificant. This fits with the hypothesis of a diminishing substitution effect.

A.5 Robustness

Table 6: Robustness (High ranking universities)

VARIABLES	Pre-empt	Shock	Short run
trend	0.0018	0.0003	0.0008
	(0.0044)	(0.0039)	(0.0039)
post-reform		0.0050	0.0007
		(0.0055)	(0.00605)
rank	-0.0009*	-0.0008	-0.0008
	(0.0005)	(0.0005)	(0.0005)
rank * trend	0.0002**	0.0002**	0.0002**
	(0.0001)	(0.0001)	(0.0001)
pre-empt	-0.0015		
	(0.0023)		
2012 shock		0.0024	
		(0.0035)	
2 year shock			0.0046
			(0.0036)
location * trend	Yes	Yes	Yes
Constant	0.142	0.128	0.0794
	(0.150)	(0.149)	(0.176)
Observations	259	259	259
R-squared	0.719	0.723	0.724
Number of uniqueid	37	37	37

Robust standard errors in parentheses, clustered by university
*** p<0.01, ** p<0.05, * p<0.1

The results in table 6 outline three key robustness tests. Firstly, there is no pre-emption of the policy. The negative sign is in line with the literature, which found that there was a drop in the number of individuals taking gap years in 2011 to avoid paying higher levels of fees, however, it is not significant. Secondly, the policy is robust to the policy effect dissipating after a year; the Shock regression outlines that there is no statistically significant evidence of a one-year shock. Finally, the short run regression finds that the regression is robust to a short run effect.

However, the large coefficient compared to the post-reform dummy coefficient is a cause for concern and highlights a major limitation of the analysis. The removal of the cap on the number of places universities could offer in 2015 means that there is a limit of three years over which this shock can be analysed. Given the magnitude of the short run and post-reform coefficients in column three, it is entirely plausible that this limit changes how the policy is interpreted. As mentioned in the conclusion, the longevity of the effect is called into question by this result.